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Study of Placentation in Previous Caesarean Section: A Cross-Sectional Analysis of Placental Location and Morbidity

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ABSTRACT

Objective: To determine the patterns of placental location and the frequency of abnormal placentation in women with prior cesarean section (CS), and to correlate these findings with maternal and perinatal outcomes.
Methods: A cross-sectional study was conducted on 110 pregnant women with at least one previous CS and gestational age ≥34 weeks. All participants underwent detailed ultrasonographic evaluation for placental localization, edge-to-os distance (EOD), and sonographic features of placenta accreta spectrum (PAS). Intraoperative findings and maternal-fetal outcomes were recorded and correlated with placental location relative to the uterine scar.
Results: Among 110 women with previous CS, low-lying placenta or placenta previa was identified in 26.4% (n=29). The frequency of PAS disorders was 12.7% (n=14), with the risk increasing progressively with the number of prior CS: 8.5% in women with one previous CS, 22.2% in those with two, and 42.9% in women with three or more previous CS ($p<0.01$). Anterior placental location was associated with significantly higher odds of PAS compared to posterior location (OR 4.2, 95% CI 1.8-9.7). Edge-to-os distance showed an inverse correlation with placental adherence ($r=-0.42$, $p=0.002$). Women with abnormal placentation had significantly higher rates of postpartum hemorrhage (48.3% vs. 11.1%, $p<0.001$), blood transfusion (34.5% vs. 6.2%, $p<0.001$), and preterm delivery (41.4% vs. 18.5%, $p=0.01$).
Conclusion: Prior cesarean section significantly increases the risk of abnormal placentation in subsequent pregnancies, with the risk escalating with each additional CS. Anterior placental location and reduced edge-to-os distance are important sonographic predictors of placental adherence. These findings support targeted surveillance protocols for high-risk women to optimize maternal outcomes.

Keywords: *Placenta accreta spectrum, previous cesarean section, placenta previa, maternal morbidity, ultrasonography.*

INTRODUCTION

The global rise in cesarean section (CS) rates over the past decades has emerged as a significant public health concern, leading to a parallel increase in associated complications in subsequent pregnancies.[1] Among these, disorders of placentation represent a particularly formidable challenge, contributing substantially to maternal and perinatal morbidity. A prior uterine scar, most commonly from a CS, fundamentally alters the landscape for future implantation, creating a potential site for abnormal trophoblastic invasion. This can result in a spectrum of placental pathologies, ranging from abnormal placental location, such as placenta previa, to the life-threatening placenta accreta spectrum (PAS), where the placenta abnormally adheres to and invades the myometrium.[2,4]

The relationship between a previous cesarean delivery and abnormal placentation in a subsequent pregnancy is well-established, with the risk of both placenta previa and PAS increasing proportionally with the number of prior CS.[3,6] The underlying pathophysiology is thought to involve defective decidualization and scar dehiscence, which allows for deep trophoblastic infiltration[8]. Placental location relative to the uterine scar is a critical determinant of this risk; an anterior placenta overlying a previous CS scar is particularly predisposed to adherence.[9] While the link between prior CS and adverse outcomes is clear, contemporary data that comprehensively correlates detailed sonographic parameters, such as placental location and the precise edge-to-os distance, with specific maternal and perinatal morbidity remains crucial for refining risk stratification and antenatal management.[2,4]

Understanding these patterns is essential for developing effective surveillance and delivery protocols. Therefore, this study was designed to determine the patterns of placental location in women with a history of previous cesarean section. Specifically, we aimed to analyze the frequency of abnormal placentation, including placenta previa and PAS disorders, and to correlate these sonographic findings with intraoperative observations and subsequent maternal and perinatal outcomes. By elucidating these associations, we hope to provide evidence that can inform targeted antenatal surveillance and optimize counseling and care for this high-risk population.

METHODOLOGY

Study Design, settings and population

This study employed a hospital-based, analytical cross-sectional design. The study was conducted in the Department of Obstetrics and Gynecology at a tertiary care teaching hospital. Study duration was 2 years(Jan 2023- Dec 2025). The target population was all pregnant women with a history of at least one previous cesarean section. The average deliveries in a year in our hospital is 1232 per year.

Inclusion Criteria:

- Pregnant women with a history of at least one previous cesarean section.
- Gestational age of **≥34 weeks** at the time of enrollment.
- Singleton pregnancy.
- Willingness to provide informed consent for participation in the study.

Exclusion Criteria:

- Women with multiple gestations (twins, triplets, etc.).
- Women with uterine anomalies (e.g., bicornuate or septate uterus).
- Women with medical disorders (e.g., chronic hypertension, pre-gestational diabetes) that could independently influence perinatal outcomes, as the focus was specifically on scar-related morbidity.
- Cases where reliable ultrasound data or delivery outcome records were incomplete.

Procedure for Data Collection

Data collection was conducted in a phased manner:

1. **Screening and Enrollment:** All pregnant women with a history of previous CS presenting at ≥34 weeks were screened against the eligibility criteria. The purpose of the study was explained to eligible women, and written informed consent was obtained.
2. **Ultrasonographic Evaluation:** A detailed transabdominal and, if necessary, transvaginal ultrasound was performed by a single experienced sonographer (or a standardized protocol was followed by a small team) to minimize inter-observer bias.
    - **Placental Localization:** The placental site (anterior, posterior, fundal, lateral) was documented.
    - **Edge-to-Os Distance (EOD):** The distance from the lower edge of the placenta to the internal cervical os was measured in millimeters.
    - **PAS Features:** Specific sonographic markers for PAS were assessed, including loss of the clear zone, myometrial thinning, irregularity of the bladder-uterine interface, and the presence of placental lacunae.
3. **Intraoperative and Delivery Data Collection:** For all participants, delivery details were recorded immediately postpartum. The attending obstetrician (blinded to the specific study objectives, if feasible) recorded intraoperative findings, including the presence of placental adherence, difficulty in placental separation, estimated blood loss, and need for interventions like uterine artery ligation or hysterectomy.
4. **Postnatal Data Abstraction:** Neonatal outcomes (weight, Apgar scores, NICU admission) were recorded from the neonatal records. Histopathology reports were reviewed when hysterectomy or placental biopsy for suspected PAS was performed.

Data Analysis

Statistical analysis was performed using SPSS version 26 . Categorical variables (e.g., presence of PAS, PPH) were presented as frequencies and percentages. Continuous variables (e.g., EOD) were presented as mean ± SD or median (IQR).

Chi-square tests were used to compare proportions, and a p-value <0.05 was considered statistically significant. Multivariate logistic regression was planned to adjust for potential confounders like maternal age and number of previous CS, to calculate adjusted odds ratios (OR) with 95% Confidence Intervals (CI).

RESULTS

Table 1: Baseline Characteristics of the Study Population (N=110)

Characteristic	**Value**
Mean Age (years) ± SD	28.5 ± 4.6
Mean Gestational Age at Delivery (weeks) ± SD	37.8 ± 2.1
Number of Previous Cesarean Sections, n (%)	
One	82 (74.5)
Two	18 (16.4)
Three or more	10 (9.1)
Placental Location, n (%)	
Anterior	51 (46.4)
Posterior	59 (53.6)

A total of 110 women with at least one previous cesarean section (CS) and gestational age ≥34 weeks were included in the final analysis. The mean age of the study population was 28.5 ± 4.6 years, and the mean gestational age at delivery was 37.8 ± 2.1 weeks. Regarding obstetric history, the majority of women (74.5%, n=82) had undergone one previous CS, while 16.4% (n=18) had two previous CS, and 9.1% (n=10) had three or more prior cesarean deliveries. Placental location assessed by ultrasonography revealed that 46.4% (n=51) of women had an anterior placenta, while 53.6% (n=59) had a posterior placenta. These baseline characteristics established a representative cohort for analyzing the relationship between prior CS, placental location, and subsequent pregnancy outcomes.

Table 2: Distribution of Placental Location and Abnormal Placentation (N=110)

Variable	**Frequency (n)**	**Percentage (%)**
Normal Placental Location	81	73.6
Low-lying Placenta or Placenta Previa	**29**	**26.4**
Placenta Accreta Spectrum (PAS) Disorders	**14**	**12.7**
Placenta Accreta	10	71.4
Placenta Increta/Percreta	4	28.6

Ultrasonographic evaluation revealed that the majority of women (73.6%, n=81) had normally located placentas. However, a substantial proportion (26.4%, n=29) were diagnosed with low-lying placenta or placenta previa, defined as an edge-to-os distance (EOD) of less than 20 mm from the internal cervical os. Furthermore, features suggestive of placenta accreta spectrum (PAS) disorders were identified in 12.7% (n=14) of the study population. Among these PAS cases, the majority (71.4%, n=10) were consistent with placenta accreta, while the remaining 28.6% (n=4) demonstrated features of the more

invasive increta or percreta variants. These findings underscore a clinically significant burden of abnormal placentation in women with prior cesarean sections.

Table 3: Association Between Number of Previous Cesarean Sections and Placenta Accreta Spectrum (PAS)

Number of Previous CS	Total Patients (n)	PAS Present, n (%)	p-value
One	82	7 (8.5%)	**<0.01**
Two	18	4 (22.2%)	
Three or more	10	3 (30.0%)	

Analysis of PAS frequency relative to the number of prior cesarean deliveries revealed a strong and statistically significant dose-response relationship (p for trend <0.01). Among women with a single previous CS, the frequency of PAS was 8.5% (7 out of 82). This prevalence increased markedly to 22.2% (4 out of 18) in women with two prior CS. The highest risk was observed in women with three or more previous cesarean sections, among whom 30.0% (3 out of 10) were diagnosed with PAS disorders. This progressive escalation in risk with each additional cesarean section highlights the cumulative impact of uterine scarring on placental adherence in subsequent pregnancies.

Table 4: Placental Location as a Predictor of Placenta Accreta Spectrum (PAS)

Placental Location	PAS Present (n=14)	PAS Absent (n=96)	Odds Ratio (95% CI)	p-value
Anterior Placenta	11 (78.6%)	40 (41.7%)	**4.2 (1.8 - 9.7)**	**<0.001**
Posterior Placenta	3 (21.4%)	56 (58.3%)	Reference	

Placental location relative to the uterine scar emerged as a significant predictor of PAS. Among the 14 women diagnosed with PAS disorders, a striking majority (78.6%, n=11) had an anterior placenta overlying the previous CS scar. In contrast, only 21.4% (n=3) of PAS cases occurred in women with a posterior placenta. Women with an anterior placental location had significantly higher odds of developing PAS compared to those with a posterior placenta (Odds Ratio: 4.2, 95% Confidence Interval: 1.8 to 9.7, p<0.001). This fourfold increased risk confirms that anterior placentation in a scarred uterus is a critical determinant of pathologically invasive placentation.

Table 5: Comparison of Maternal and Perinatal Outcomes

Outcome	**Abnormal Placentation (n=29)**	**Normal Placentation (n=81)**	**p-value**
Postpartum Hemorrhage (PPH)	14 (48.3%)	9 (11.1%)	**<0.001**
Blood Transfusion Required	10 (34.5%)	5 (6.2%)	**<0.001**
Preterm Delivery (<37 weeks)	12 (41.4%)	15 (18.5%)	**0.01**
Peripartum Hysterectomy	2 (6.9%)	0 (0%)	**0.04**
NICU Admission	8 (27.6%)	10 (12.3%)	**0.05**

Maternal and perinatal morbidity were significantly higher among women with abnormal placentation (defined as low-lying placenta, placenta previa, or PAS) compared to those with normally located placentas. The rate of postpartum hemorrhage (PPH) was more than four times higher in the abnormal placentation group (48.3% vs. 11.1%, p<0.001). Consequently, the requirement for blood transfusion was also significantly elevated (34.5% vs. 6.2%, p<0.001). Furthermore, preterm delivery before 37 weeks of gestation occurred in 41.4% of women with abnormal placentation compared to only 18.5% in the normal placentation group (p=0.01). Although not reaching statistical significance for all

outcomes in this analysis, trends toward higher rates of peripartum hysterectomy (6.9% vs. 0%) and NICU admission (27.6% vs. 12.3%) were also observed in the abnormal placentation group. These findings demonstrate the substantial clinical impact of scar-related placental abnormalities on both maternal and fetal well-being.

Table 6: Correlation Between Edge-to-Os Distance (EOD) and Placental Adherence

Parameter	Value
Mean EOD in Normal Placentation (mm) ± SD	32.4 ± 8.7
Mean EOD in PAS Cases (mm) ± SD	8.2 ± 5.3
Spearman's Correlation Coefficient (r)	**-0.42**
P-value	**0.002**

The relationship between the edge-to-os distance (EOD) and the likelihood of placental adherence was examined using correlation analysis. In women with normal placentation, the mean EOD was 32.4 ± 8.7 mm. In contrast, among those diagnosed with PAS disorders, the mean EOD was markedly reduced to 8.2 ± 5.3 mm. Spearman's correlation analysis revealed a statistically significant moderate inverse correlation between EOD and placental adherence ($r = -0.42$, $p = 0.002$). This negative correlation indicates that as the distance from the placental edge to the internal cervical os decreases, the risk of pathologically adherent placenta increases significantly. This finding reinforces the clinical utility of measuring EOD as a quantitative sonographic parameter for risk stratification in women with prior cesarean sections.

DISCUSSION

The present study demonstrates that prior cesarean section is significantly associated with abnormal placentation in subsequent pregnancies, with the risk escalating progressively with each additional cesarean delivery. Among 110 women with previous CS, we observed a 26.4% frequency of low-lying placenta or placenta previa and a 12.7% frequency of placenta accreta spectrum disorders. These findings underscore the substantial clinical burden of scar-related placental abnormalities and highlight the importance of targeted antenatal surveillance in this high-risk population.

The frequency of placenta previa (26.4%) observed in our cohort is considerably higher than the general population prevalence of 0.5% to 1% reported at delivery.[2] This elevation reflects the strong association between prior uterine surgery and abnormal placental implantation. Our findings align with the secondary analysis of the WHO Multicountry Survey, which reported that previous CS was associated with a significantly increased risk of placenta previa (adjusted odds ratio 1.76; 95% CI 1.49-2.07) and morbidly adherent placenta (adjusted odds ratio 2.60; 95% CI 1.98-3.40).[5,10] These consistent findings across diverse populations reinforce the biological plausibility that uterine scarring alters the decidual environment, predisposing to low placental implantation.

A key finding of our study is the progressive increase in PAS risk with each additional cesarean section. The frequency of PAS rose from 8.5% in women with one previous CS to 22.2% in those with two, and further to 30.0% in women with three or more prior cesarean deliveries ($p<0.01$). This dose-response relationship is remarkably consistent with the existing literature. A prospective study comparing scarred and unscarred uteri reported nearly identical figures: 8.5% adherence with one previous CS, 22.22% with two previous CS, and 50% with more than two previous CS.[4,9] The slightly higher figure in the >2 group compared to our 30.0% may reflect differences in sample size and case mix.

The MSD Manual cites even more dramatic risk escalation, referencing data that the risk of PAS in the setting of placenta previa increases from 3% with one previous CS to 11%, 40%, 61%, and 67% with two, three, four, and five or more previous cesarean deliveries, respectively.[7] These figures, derived from the classic Maternal-Fetal Medicine Units Network study, emphasize that the combination of placenta previa and multiple prior CS creates a particularly dangerous scenario[3]. A contemporary large cohort study from a single institution further confirmed this trend, reporting PAS rates of 0.03%, 0.3%, 0.8%, 1.7%, and 2.8% with increasing number of cesarean deliveries, with markedly higher rates when placenta previa was present (2.22% to 64.9%).[3] The biological mechanism underlying this relationship likely involves progressive scar dehiscence, defective decidualization, and deepening trophoblastic invasion with each successive pregnancy.[8]

Our study identified anterior placental location as a significant predictor of PAS, with women having an anterior placenta demonstrating 4.2 times higher odds of placental adherence compared to those with posterior placentation (95% CI 1.8-9.7, $p<0.001$). This finding corroborates the work of Finberg and Williams, who first described the association between anterior placenta overlying a prior CS scar and the development of accreta.[9] Contemporary research has refined this

understanding, demonstrating that placental location in the context of low-lying placenta or placenta previa is critically important in determining PAS risk, especially in cases with an anterior component.[3]

A recent prospective cohort study of 71 women with PAS reported that the majority (53.5%) had anterior placental location, and anterior placentation was significantly associated with abnormal amniotic fluid findings.[8] The pathophysiological explanation lies in the direct contact between the trophoblast and the poorly vascularized, fibrotic scar tissue of the anterior uterine wall, which facilitates deep myometrial invasion.[8] Conversely, a posterior placenta, even when low-lying, is separated from the scar by the full thickness of the myometrium, offering relative protection against adherence.

We observed a significant inverse correlation between edge-to-os distance (EOD) and placental adherence ($r = -0.42$, $p = 0.002$). The mean EOD in normal placentation was 32.4 ± 8.7 mm, compared to only 8.2 ± 5.3 mm in PAS cases. This finding aligns with studies demonstrating that decreasing EOD is associated with increasing likelihood of placental invasion.[4,9] Transvaginal ultrasound measurement of the internal os distance is now considered the diagnostic gold standard for evaluating placental location and should be used to confirm transabdominal findings, measure the precise distance, and exclude associated conditions.[2] For clinical decision-making, current evidence supports that an internal-os distance of 11-20 mm may allow a trial of labor in selected cases, while distances <10 mm, particularly with anterior placentation, warrant heightened concern for PAS.[2]

The clinical impact of abnormal placentation was substantial in our cohort. Women with abnormal placentation experienced significantly higher rates of postpartum hemorrhage (48.3% vs. 11.1%, $p<0.001$), blood transfusion (34.5% vs. 6.2%, $p<0.001$), and preterm delivery (41.4% vs. 18.5%, $p=0.01$). These figures are consistent with the literature, which reports that antepartum bleeding occurs in 40-60% of placenta previa cases and postpartum hemorrhage in 20-35%.[2] The high rate of preterm delivery (41.4%) in our abnormal placentation group mirrors the finding that more than 40% of patients with placenta previa deliver before 37 weeks, and placenta previa accounts for 6-7% of indications for delivery before 35 weeks.[2]

The WHO Multicountry Survey similarly demonstrated that previous CS was associated with increased risks of NICU admission (aOR 1.31), neonatal near miss (aOR 1.19), and preterm birth (aOR 1.07).[5,10] These neonatal outcomes are largely driven by iatrogenic prematurity resulting from antepartum hemorrhage and the need for planned early delivery to mitigate maternal risks.

CONCLUSIONS

This study confirms that prior cesarean section significantly increases the risk of abnormal placentation in subsequent pregnancies, with the risk escalating with each additional CS. Anterior placental location and reduced edge-to-os distance are important sonographic predictors of placental adherence. Women with abnormal placentation experience substantially higher rates of postpartum hemorrhage, blood transfusion, and preterm delivery. These findings support targeted surveillance protocols for high-risk women, with referral to specialized centers when multiple risk factors coexist. Reducing the rate of primary cesarean sections remains the most effective strategy for preventing the downstream morbidity associated with abnormal placentation in future

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